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and an ionic conductance rate of at least 5.1 µmhos/min.

190 191. The composite membrane of claim 190, wherein the thickness of said composite membrane is in the range of between 0.06 and 0.8 mils.

191 192. The composite membrane of claim 190, wherein the thickness of said composite membrane is in the range of between about 0.5 and 0.8 mils.

192 193. The composite membrane of claim 190, wherein the thickness of said composite membrane is at most 0.5 mils.

193 194. The composite membrane of claim 190, wherein said at least one ion exchange resin comprises a mixture of/ion exchange resins.

The composite membrane of claim 190, wherein said at least one ion exchange resin comprises a perflue shated sulfonic acid resin.

195 196. The composite membrane of claim 190, wherein said at least one ion exchange resin comprises/a perfluorinated carboxylic acid resin.





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196197. The composite membrane of claim 1967, wherein said at least one ion exchange resin comprises a polyvinyl alcohol.

189 The composite membrane of claim 190, wherein said at least one ion exchange esin comprises a divinyl benzene resin

198 199. The composite membrane of claim 190, wherein said at least one ion exchange resin comprises a styrene-based polymer.

The composite membrane of claim 190, wherein said at least one ion exchange resin further comprises/metal salts with or without a polymer.

200 201. The composite membrane of claim 194, wherein said mixture of ion exchange resins includes at least two of a perfluorinated sulfonic acid resin, a perfluorinated carboxylic acid resin, a polyvinyl alcohol resin, a divinyl benzene resin or a styrene-based polymer.

193 The composite membrane of claim 194, wherein said at least one ion exchange s a perfluorosulfonic acid/tetrafluoroethylene copolymer resin.

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202 203. The composite membrane of claim 190, further comprising a reinforcement

backing bonded to a side thereof.

203 204. An integral substantially air occlusive integral composite membrane having a support with a microstructure of pores, said microstructure filled with an ion exchange resin, said composite membrane has an ionic conductance rate of at least 5.1 µmhos/min, said composite membrane prepared by,

- (a) providing a support having a microstructure of micropores;
- (b) sequentially applying an ion exchange resin solution to each major surface of said support; and
- (c) repeating step (b) until said micropores are sufficiently filled with ion exchange resin to form an air occlusive integral composite membrane.

204 205. The composite membrane of claim 204, wherein said step (b) further includes,

(b1) drying said support after each application of ion exchange resin solution to remove solvent from said solution.

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The composite membrane of claim 204, wherein said step (b) includes at least three successive applications of said ion exchange resin solution.

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206 207.

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The composite membrane of claim 204, wherein said step (b) includes at least

four successive applications of said ion exchange resin solution.

The composite membrane of claim 204, wherein said step (b) includes at least

three successive applications of said ion exchange resin solution, each followed by a drying step.

293 208 209. The composite membrane of claim 204, wherein said step (b) includes at least

four successive applications of said ion exchange resin solution, each followed by a drying step.

The composite memorane of claim 204, having a thickness in the range between

0.06 and 0.8 mils.

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The composite membrane of claim 204, having a thickness in the range of

between about 0.5 and at/most 0.8 mils.

The composite membrane of claim 204, having a thickness of at most about 0.5

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2/2 2/3. The composite membrane of claim 204, wherein said ion exchange resin is a

mixture of resins.

The composite membrane of claim 204, wherein said ion exchange resin is a

perfluorinated sulfonic acid resin.

214 215. The composite membrane of claim 205, wherein said drying is conducted at about

room temperature.

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The composite membrane of claim 204, wherein said ion exchange resin solution

is applied in the presence of a surfactant.

The composite membrane of claim 205, wherein said ion exchange resin solution

is applied in the presence of a surfactant.

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27 278. A method of preparing a substantially air occlusive integral composite comprising:

- (a) providing a support having a migrostructure of micropores;
- (b) sequentially applying an ion exchange resin solution to each major surface of said

support; and

(c) repeating step (b) until said micropores are sufficiently filled with ion exchange resin to form an air occlusive integral composite membrane which has an ionic conductance rate of at least 5.1 μmhos/min.

US 219. The method of claim 218, wherein said step (b) includes at least three successive applications of said ion exchange resin solution.

719 220. The method of claim 218, wherein said step (b) includes at least four successive applications of said ion exchange resin solution.

221. The method of claim 218, wherein said step (b) includes at least two successive applications of said ion exchange resin solution, each followed by a drying step.

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The method of claim 218, wherein said step (b) includes at least three successive applications of said ion exchange resin solution, each followed by a drying step.

200 223. The method of claim 218, wherein said composite membrane has a thickness within the range of 0.06 to 0.8 mils.

The method of claim 218, wherein said composite membrane has a thickness within the range of 0.5 to 0.8 mils.

224 225. The method of claim 218, wherein said composite membrane has a thickness of at most 0.5 mils

217 The method of claim 218, wherein said ion exchange resin is a mixture of resins.

U7 The method of claim 218, wherein said ion exchange resin is a perfluorinated sulfonic acid resin.



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227. The method of claim 219, wherein said at least three successive applications of said ion exchange solution include alternate applications of said resin solution to a first side of said support and then to a second side of said support.

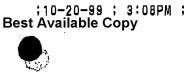
228. A fuel cell including an ultra-thin/air impermeable integral composite membrane; said composite membrane comprising;

a support having a microstructure of micropores, said microstructure defining a porosity in the range of about 70% to 95% within said support,

at least one ion exchange resin/filling said microstructure such that said composite membrane is air impermeable, said composite membrane having a thickness of at most 0.8 mils.

The fuel cell of claim 228, wherein said composite membrane has a thickness in the range of between 0.06/and at most 0.8 mils.

230. The fuel cell of claim 228, wherein said composite membrane has a thickness of at most 0.5 mils.





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231. The fuel cell of claim 228, wherein said at least one ion exchange resin comprises a mixture of ion exchange resins.

232. The fuel cell of claim 228, wherein said at least one ion exchange resin comprises a perfluorinated sulfonic acid resin.

233. The composite membrane of claim 190, wherein the thickness of said composite membrane is at most 0.4 mils.

234. The composite membrane of claim 190, wherein the thickness of said composite membrane is at most 0.3 mils.

235. The composite membrane of claim 190, wherein the thickness of said composite membrane is at most 0.2 mils.

236. The composite membrane of claim 190, wherein the thickness of said composite membrane is at most 0.1 mils.



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The composite membrane of claim/211, wherein the thickness of said composite membrane is at most 0.4 mils.

The composite membrane of claim 211, wherein the thickness of said composite 238. membrane is at most 0.3 mils.

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The composite membrane of claim 211, wherein the thickness of said composite 239. membrane is at most 0.2 mile

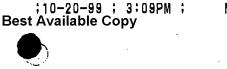
The composite membrane of claim 211, wherein the thickness of said composite 240. membrane is at most 0

The composite membrane of claim 218, wherein the thickness of said composite membrane is at most 0.4 mils.

217 The composite membrane of claim 218, wherein the thickness of said composite 242. membrane is at most 0.3 mils.

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217 243. The composite membrane of claim 218, wherein the thickness of said composite membrane is at most 0.2 mils.

The composite membrane of claim 218, wherein the thickness of said composite membrane is at most 0.1 mils.

The composite membrane of claim 204, wherein the thickness of said composite membrane is at most 0.4 mils.

246. The composite membrane of claim 204, wherein the thickness of said composite membrane is at most 0.3 mils.

The composite membrane of claim 204, wherein the thickness of said composite 247. membrane is at most 0.2 miles

103 The composite membrane of claim 204, wherein the thickness of said composite membrane is at most 0.1 mils

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An integral air impermeable composite membrane comprising:

a support having a microstructure of micropores, said microstructure defining a porosity

in the range of about 70% to 98% within said support,

at least one ion exchange resin filling said microstructure such that said composite membrane is air impermeable, said composite membrane having a thickness of at most 0.8 mils.

3º 280. The composite membrane of claim 249, wherein the thickness of said composite membrane is in the range of between 0.06 and 0.8 mils.

29 The composite membrane of claim 249, wherein the thickness of said composite membrane is in the range of between about 0.5 and 0.8 mils.

The composite membrane of claim 249, wherein the thickness of said composite membrane is at most 0.5 mils.

The composite membrane of claim 249, wherein said at least one ion exchange resin comprises a mixture of ion exchange resins.

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